"The Tasmanian Naturalist"

New Series, Vol. I., No. I.

It is with the greatest pleasure that the Tasmanian Field Naturalists' Club presents the first number of the new series of its Journal. "The Tasmanian Naturalist" commenced publication soon after the inauguration of the Club in 1904, and ran until 1911, when it gradually became overwhelmed with financial problems. Its objects during those issues were to provide a forum for the promulgation of the work of the Club, and to assist in the advancement of the knowledge of Tasmanian natural science.

Since 1911 costs have increased enormously, and the resources of the Club, in common with those of learned societies throughout the world, have barely held their own. However, with the assistance of "News Ltd.," the Club is making a second endeavour to publish its Journal, and the Committee look to members for the degree of practical co-operation, and the Club looks to the public of the State for the necessary sympathetic interest to enable this Journal to continue its existence.

We, the present and future contributors to "The Tasmanian Naturalist," are firmly of the opinion that a knowledge and appreciation of natural laws and the principles governing the forces that control the world around us are essential to human happiness and economic progress, and even to the very existence of life itself.

We are convinced that the welfare and progress of the community are based on deeper principles than economic laws. We know that man cannot fight his environment. He may occasionally guide nature, but in general he must fit himself into the general scheme. To do this he must know nature know what we are, and know the forces that govern life on the globe. Therefore these pages will find no room for superstition and that great enemy of progress in thought, "I believe." Here there will be no place for any story but the truth, and the truth tested by all the means at our disposal.

Further, this journal will be devoted to the story which concerns us—to the story of our homeland, Tasmania. We leave the daffodil and the nightingale to those who know them. It will be the well-known odour of our homeland bush and the free, rustling gusts of our wild mountain tops that will fill these pages.

Our aim in this Journal is to present our ideas, observation and deductions concerning the flowers and trees, the sea shore and inland landscape, the animals, birds and insects of Tasmania. We conscientiously think that a knowledge of the world around us gives a far truer ideal in education than the dead past of forgotten peoples, the wonders of other lands, whose existence scarcely concerns us, and the stories that are called literature, but which still are mere fiction, and we are of the opinion that to progress we must turn our back on the past, and look to the wonderful vista of natural science that is daily being unfolded before our eyes.

We know that many slips will be made from time to time, but this is but a small penalty for progress, and progress is the keynote of our study. We know that this publication will reach only a few of our citizens, but it will do good if it brings light to a few who do not consider their education yet completed, and indicates that there do exist in the great world out of doors forces and facts whose presence is never dreamed of by the Saturday afternoon football crowd. And we shall be more than happy if the revelation of the existence of these mysteries will lead an occasional enquiring mind to ask himself, "Why?" and to go and find the answer, and add his name to the tiny list of those who are endeavouring to place Tasmania on the scroll of peoples who have contributed some assistance towards the advancement of civilisation.

THE TASMANIAN FIELD NATURALISTS' CLUB.

The Tasmanian Naturalist

THE JOURNAL OF THE

Tasmanian Field Naturalists' Club

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Fish Fauna of Tasmania

The fish of Tasmania are of interest owing to the Southern position of our island, which, in some ways, form a connecting link between the fauna of Australia and the subantarctic regions.

In the grouping of the greater divisions of the zoological kingdom the fishes (Pisces) form the lowest class of the vertebrates, or backbone animals, and the lancelets, which are often grouped with the fishes, realy form a connecting link between the invertebrates and the vertebrates.

Lancelets are small semi-transparent marine animals found burowing in the sand. They are from 30 to 40 mm. long and are without brain, cranium, or jaws.

A considerable advancement in development is shown by the lampreys, which are cold-blooded vertebrates without limbs or skulls. The mouth lacks jaws., and is in the form of a suctorial disc. Both the Short-headed and the Pouched lamprey occur in Tasmania.

Shark Species.

Above the lampreys are the sharks (Selachii) which are distinguished by the absence of a bony skeleton, the absence of the true fish-like scales, and the presence of the five to seven gill openings, which are on the sides. The members of this order constitute the larger predaceons fishes, representatives of which are found all over the world. The seven-gilled and the one-finned shark, Port Jackson, wobbegong or carpet shark, collared cat shark, varied cat shark, spotted cat shark, swell shark, thresher shark, grey nurse and the blue pointer have all been recorded from Tasmania.

The small sharks known as "dog fish" are represented by such species as the piked dog fish, spotted dog fish, and prickly dog fish, whilst two varieties of the peculiar saw sharks are met with.

The angel shark, with its flat depressed body, approaches, in some respects, the members of the next order, the rays.

Rays (Batoidea) are immediately distinguished from sharks by the disc-like form of the body and the fact that the gill openings are on the under surface. Tasmanian representatives of this order include such species as the fiddler, Tasmanian numb fish, rough-backed skate, thorn-backed skate, smooth stingaree, banded stingaree, green-backed stingaree, sandy-backed stingaree and the eagle (or whiptail) ray.

Ghost sharks (Holocephali) are distinguished, apart from their peculiar form, owing to the fact that they have but one external gill opening. They also possess an erectile dorsal spine. The peculiar elephant fish is the more common Tasmanian representative of the order, but the ghost shark also appears here.

Fishes proper are distinguished from the sharks, rays, etc., by the presence of the operculum, or gill cover. The first division contains the trout-like fishes such as herrings, etc. Certain species of cosmopolitan range are grouped within this order, and in the future certain of these should prove of great economic impoftance, as they are practically identical with European forms which are regarded as of great value.

Australian Anchovy.

The Australian anchovy is practically identical with the European form. The pelagic sprats, both the blue and the robust, occasionally appear in shoals off the coast, whilst the Australian pilchard is very similar to the European pilchard or sardine. The beaked salmon (sand eel of New Zealand) is occasionally taken in Tasmanian waters. It frequents the muddy bottom of certain rivers, grows to about a foot or eighteen inches in length, with cylindrical body, and a pointed overhanging snout with two barbels.

The jollytail is a well-known form common in estuaries and creeks. The Mersey jolly-tail is a variety. Jolly-tails are really minnows, and represent the Salmonidae in the indigenous fish fauna of Tasmania.

In the lakes and the higher reaches of the fresh water streams the jollyta.ls give place to the spotted mountain trout. The lake trout, which occurs in the Great Lake and the other lakes and streams at high altitude, is a variety of the spotted trout.

The order under review includes salmon, trout, etc., and many forms which have been introduced from other countries. As examples of species which have been introduced into Tasmanian waters the following may be mentioned:—Salmon, brown trout, rainbow trout, Loch Leven trout, salmon trout, American brook trout, sebago salmon, sock-eyed salmon, quinnat salmon.

The Smelt.

To return to the indigenous fauna of this order the Argentine or Siel smelt is occasionally obtained during trawling operations off the coast, whilst the Australian grayling or "cucumber herring" is sometimes taken on the north-east coast. It was very plentiful at one time, but its numbers have greatly diminished. The small species known as the Derwent smelt (40-50 mm.) is found in the Derwent, whilst the larger Tasmanian smelt (60-70 mm.) or "whitebait" also occurs.

Following the herrings are representatimes of the order Iniomi. Two species belonging to this order have been recorded from Tasmania, the cucumber fish, which was secured by trawling off the East Coast, and the lancet fish. The latter is rare. It is a very formidable species, growing up to six feet in length and possessing "a large barracouta-like mouthful of teeth." The dorsal fin is considerably elevated and extended.

The following group includes such fish as the European carp, gold fish, and English tench, which are not native to our island, but have been introduced at various times.

The next group to be considered are the eels, the first order of which embraces the pigmy eels, which are small eel-like creatures found under stones, etc., along the shore. They have but one gill opening which is on the ventral surface.

True Eels.

The true eels (Apodes) have two gill openings on the sides. Some species are found in inland waters, but descend to the sea to breed, the young returning to the lakes and rivers. The short-finned and the closely allied long-finned eel may be mentioned in this regard. The larger conger eels are found around the coasts, whilst the little conger, which is often referred to as the silver eel in Tasmania, frequents certain rivers and estuaries.

The minute Tasmanian worm eel has been recorded from the East coast.

Following the eels is the order Solenichthyes, to which belong the sea horses, pipe fish, bellows fish, and other species of a like nature. The sea horses are typical of the present group. They possess a peculiar elongated tube-like snout. The body is often encased in a series of bony rings. Several kinds of sea horses are met with, including the leafy sea horse. A point of interest is that the male has a pouch and carries the eggs about after they have been deposited by the female.

Bellows Fish.

Three species of Bellows fish have been recorded from Tasmania, all of which possess an elongated snout and two dorsal fins, the anterior one being compressed into a spine.

The Pipe fishes, which are closely related to the sea horses, are common in Tasmanian waters half a dozen or more species having been described. Belonging to this order is the Opah, a giant sea fish. One specimen has been recorded from Tasmania, and is now in the Tasmanian Museum.

Although included in a separate order the Dragon fishes approach the previous group in that their bodies are encased in bony rings. The snout is also produced, but it lacks the tube-like process of the Pipe fishes. The Dragon fish is a small species 50 to 90 mm. long found in many places such as among the shallows of the Derwent estuary. It is occasionally taken in scallop dredges.

Following the Dragon Fish and the Garfish, are the Rock Cods, Whiptails, etc (Anacanthini). The representatives of this latter group have no true spines in the vertebral fins. Rock Cod are extremely common in many localities, but fishermen, as a rule, do not distinguish between the three species met with. It must also be remembered that in New South Wales the fish there called the Rock Cod in the vernacular, is a species of Gurnet.

Three species of Whiptails are also found in Tasmanian waters, but as they constitute part of a family of deep-water fishes, they are seldom taken except by trawlers.

The next order embraces the Dories and other similar fishes, whilst following these are the Ribbon Fish. Both the great Oar Fish and the Ribbon Fish have been recorded from Tasmania They are peculiar-looking fishes, eel-like in form, but the body is greatly compressed.

Flat Fish.

Flounders and similar flat fish constitute the order Heterosomata. The flat fishes are those in which the body is laterally compressed to such an extent that both eyes appear on one side. The very young fry are not very different from the young of other fishes, but they soon begin to lie on one side and the lower eye in the proces of growth travels over the snout to the upper side. Three main divisions of the group are easily separated; one of which has the eyes on the left side, the second of which has the eyes on the right side, whilst the third division has the opercle and pre-opercle practically fused into one member, there being no clevage. This third division embraces the soles. The latter are rare in Tasmanian waters, being only occasionally taken in Bass Straits. The so-called "Sole" of the Tasmanian fishermen is the long snouted Flounder.

Fifty-Five Families.

Following the flat fishes comes the order Percomorphi. This division embraces a very large percentage of the total fish fauna of the island. Many varied forms are met with, but they all agree in having a number of spines in the anterior dorsal fin, whilst the ventrals never have more than one spine and five rays. Forty-two families belonging to this order occur in Tasmania, and for the purpose of the present outline it may be as well to defer consideration of these until dealing with each group in detail.

The following order (Discocephali) has but two representatives in Tasmania. The slender and the short sucker fish. These have elongate bodies with very tough skin. The top of the head has a sucking disc which enables them to cling to larger fishes and even ships.

The mailed-cheek fishes (Scleroparei) are well represented in Tasmania. Included in this order are the various gurnets, the richly-colored velvet fish, the cuma, and other gurnards, as well as the several species of flathead.

Cling fishes (Xneoptari) form a small group of fishes that attract but little notice owing to their small size. They cling to stones, etc., by means of an adhesive disc which is situated between the ventral fins.

Following these come the angler fish, or frog fish, which are distinguished by having a movable projection at the extremity of the snout. They are usually met with among weeds.

Leather jackets and other such fish constitute the order Pletognatti, the distinguishing feature of which is the absence of the ventral fin. Included in the order also are the trunk fish and the peculiar sun fish, which pelagic form is occasionally met with off the Tasmanian coast.

General Character of Fishes.

The term fish is one that is apt to be applied in a free and easy manner to many species of animals far removed from the true type. For instance, numerous representatives of the Mollusca and Crustacea are often referred to as shell fish. True fishes, however, are aquatic, vertebrated or backboned animals. They are cold-blooded and breathe by means of gills. Their external limbs are reduced to a series of fins, the arrangement and number of which plays a large part in their classification. Whales are occasionally spoken of as though they were a species of fish, but whales are true mammals, and except for aquatic habits have nothing in common with fish.

The body of a fish is usually described in detail in three main divisions, namely, the head, the trunk, and the fins. On each side of the head there is a movable flap called the opercle, although in some fishes such as the eels, it is covered with skin, whilst with the sharks, rays, etc., it is absent. The gills, which are situated under the opercle, constitute a wonderful arrangement by means of which the blood is aerated as it circulates, owing to the constant passage of water through the gills.

The trunks of fishes are usually covered with scales. The sharks exhibit a lower form of this development, the scales being of such a small enamel nature as to practically constitute a hard skin. Other fishes have scales with smooth rounded edges, technically known as cycloid scales, whilst the higher fishes show a still further development by having the edges of the scales toothed or covered with small points. The fins of fishes are of great importance in the scheme of classification, most fishes having the following:—

A fin on the back known as the dorsal fin.

A tail or caudal fin.

An anal fin situated on the under side just in advance of the tail.

A pectoral fin situated on the side just behind the opercle.

The ventral fin situated on the lower side of the body usually a little below the pectoral fin; but in some of the lower fish the ventral fin is far behind the pectorals.

The ventorals and pectorals are both paired; that is to say, there is a fin of similar shape on each side of the body, while in some fishes the dorsal fin is divided into several divisions or there may be one or more dorsals.

Again, portions of the fins may differ in character, some being separated by means of spines, and some by means of more flexible supports.

Sharks and Rays.

The sharks and rays, although differing considerably in general appearance, are grouped together in the same order for the reason that they are seen to be closely related when examined in detail. Moreover, there is a connecting link between the sharks and the rays in the peculiar-shaped Angel Shark which is occasionally taken in Tasmanian waters. The whole fish class (Pisces) is easily separated into two divisions, of which the sharks form the first and the bony fishes the second.

The characteristics of the first division are the absence of the bony skeleton, its place being taken by cartilege, the absence of the opercle and similar bones of the head, and the presence of paired claspers in the male.

A connecting link between the sharks and the bony fishes is provided by the sub-class Holocephali, under which are grouped the peculiar Elephant Sharks. The Elephant Shark is a common species in Southern Tasmanian waters, and apart from its peculiar shape is easily recognised owing to the fact that it has the gills conceealed under a cartilligenous opercle. Most Tasmanian sharks have five separate external gill openings, but there are two species, the seven-gilled and the one-finned shark, in which the number is increased to seven. In addition to the ordinary gill openings there is a smaller opening near the eye, generally referred to as the spiracle, which enables the fish to breathe when its mouth is burrowed in the sand or otherwise occupied.

Sharks and rays are in the main predaceous fishes, and as a consequence they are well adapted for their method of life. The teeth vary greatly in number and shape, and are placed in rows, which are continually growing outwards, so that a lost set of teeth is quickly replaced. The great majority of these fishes are vivaparous, that is, the young are brought forth alive, but certain of them are oviparous, among the latter being the Bull-headed or Port Jackson sharks, and some of the smaller Dog Fishes. The Rays, which are in the ordinary sense fairly slow moving creatures, frequenting the sea bottom, are oviparous.

Clive Lord.

Outlines of Tasmanian Geology

Part I.—Geological Processes.

Chapter I.—Introductory. The Science of Geology.

Section I.—Geology.

Geology is the great foundation-stone science. It teaches us the history our planet, the origins of sea and nd, the reasons for our many kinds rocks, how our present scenery was ranged, and the development of life its multitudinous forms. It is the udy of the great out-of-doors, with e whole surface and interior of the orld for its classroom. We insignifint mortals crawl on the face of the rth and wrangle about prices and honors. We undertake great ventures optimistically, or spend our lives coaxing a few pence from the unwilling soil, and we prosper or fail. Mother earth —this globe we inhabit—gives us our success, or rebuffs us, and the great controlling factor in the lives of each and every one of us is

Environment.

High above our politics, our trade, our wars, our petty lives rises this dominating influence. Geology is the science of our environment.

This is a new science, and still in the nfancy; but little by little its facts are eing uncovered, although today even he framework is scarcely apparent lso it is a universal science—its truths ust apply equally well all over the orld, and for all times, or they are llacies. Hence, we in Tasmania have ur responsibilities. We cannot hope to roduce master minds who direct the hole trend of the world's ideas, nor an we compete with the great centres f scientific research, equipped with ast paraphernalia in enquiring into the ore abstruse natural laws; but we can escribe to the world our own natural rroundings, and the world wants to now them.

At the recent Pan Pacific Science Conress held in Melbourne and Sydney ading American geologists were most ersistent in their request: "Don't worry bout theories and laboratory tests, we n do those better than you, but give descriptions of your country—we ant that." Now, much has been done this respect, but a vast amount

Still Awaits Workers.

We have in Tasmania some of the ast known tracts of the Commonealth, but the few interested in this udy cannot cope with the work. These tes, it is hoped, will serve to give our any enthusiastic trippers and bush vers sufficient insight into the groundork of the science of geology that they ll realise what they see, as they en- a holiday in the bush, and that, see-, they will remember and record. Unrtunately, we have no text book of smanian geology, and naturally ex-ples from Europe and America do t appeal to those not specially inested.

t is hoped that these brief notes will rve to fill this gap until time and ney are available for something more rthy, and that sufficient will be here nd to enable readers to realise the dden meaning in the scenery they e on, and the great foundation plan which our superstructure of civilisan is built. And perhaps some few y be added to the tiny band who are eavoring to show that Tasmania is backward in contributing her quota the sum of knowledge, and always remembering Professor David's fine senice—"No work, conscientiously done, investigation carefully carried out, will to affect the economic life of the munity."

Section 2.—Subdivisions of Geology.

Geology as a basal science merges at many points into other branches of knowledge. It draws much of its data from astronomy, chemistry and physics, and it supplies the historical background for botany, zoology and ethnology. Again its many branches have each become the subject of special studies, but geology uses all these sciences, as it requires their assistance, and unites them to explain the history of the world and the landscape and its inhabitants.

In the first place it draws on astronomy to assist in explaining the origin of the world as a planet, and the first branch of our subject is

Astronomical or Cosmic Geology.

But most geologists leave this branch to the astronomer, as too vague for practical study. Next comes geotectonic geology. This deals with the architecture of the earth's outer shell as a shell. It is world-wide in its scope, and although most important, requires very extended travel for study. This branch merges into the new science of geophysics—the study of the principles of physics that govern the behavior of the surface of the world—on the one hand, and into dynamic geology on the other hand.

It is with dynamic geology that our subject really starts. This branch, starting with the shell of the earth as we find it, examines and explains all the processes by which it is built up or broken down, or in any way affected. Having mastered the processes, their origin and effects, we can proceed to the next branch, physiographic geology, which explains by what process a given landscape has been moulded into its present form. It tells us the history of the countryside.

Now, during the earth processes that have built up the surface of the world as we see it today, rocks have been formed and remains of plants and animals have been enclosed and preserved. The branch of geology which examines the nature, composition, and formation of the rocks as individual masses of matter, is called petrology. It has a large subdivision mineralogy, which examines the structure, texture, composition, and form of the constituent parts of those rocks. The branch which examines the traces of life is called palaeontology. Both of these branches have become separate studies, but both are essential to the complete understanding of the history of our landscape. Finally ,when all the information these branches can give us is collected, we can give a

Fairly Complete History.

of our chosen piece of landscape. When much of the surface of the world is so investigated we can give a history the general outlines of which hold good everywhere. This branch is known as systematic or historical geology.

Finally when these principles are understood, and are worked out for a given district, they can be applied to assist the miner, farmer, and engineer, and to guide the geographer, economist and politician. This part of our science is often termed economic geology, and its various branches are given such names as mining geology, agricultural geology, etc. In reality geology has no such subdivisions. These are the practical application of the principles of the science to a given set of facts.

A. N. Lewis.

Chapter II.

The Globe

(Astronomic and Geotectonic Geology.)

(Section 3.)

The Early History of the Globe.

This chapter is a summary outline added solely to make our story complete. The subject is not of less relative importance than other divisions, but to study it, the whole world must be taken as a single unit, and Tasmania can add little to what is now found in standard text books, to which readers are referred for a fuller statement.

The early history of our solar system and of our world as a planet is shrouded in mystery. Much light has been thrown onthe dawn of our history by the lessons of astronomy which can show how other celestial bodies may be born, grow old, and be extinguished, and physics gives us a guide as to the possibility or otherwise of many processes.

Three great schools of thought have held sway during the last sixty years. These, in order, have been:—(1) The Nebular Hypothesis, first put forward by Laplace. This theory assumed, first a great gaseous nebula sufficiently extensive to cover the whole of our solar system and containing all the elements of the minerals we now know, but so intensely hot that they existed only in the form of gases. Nebulas certainly exist in the heavens, but it is doubtful whether they consist of gaseous material. Our parent nebula was supposed by cooling and by the action of "gravity" to have gradually commenced to revolve. As the process continued, the materials separated into rings and later into separate bodies revolving round a nucleus. These bodies, by the same process, became more and more compact. Our globe, as a typical one, in time cooled sufficiently to form a hard crust covered with water, and with a still molten interior. As the globe cooled, still more, it shrank and thus buckled the crust into continents and mountains. This theory necessitated the idea of a cooling and shrinking globe. Today we know that almost every detail of this hypothesis is unsound.

(2) The Meteoritic Hypothesis.—This was favored by Lockyer and Darwin. It explained the origin of the solar system to the collection of meteorites or similar small bodies moving freely through space, and continually augmented by a rain of similar particles. The particles were at first cold, but by continual friction the temperature rose to a great heat. Later the world started to cool down. This theory also is known now to be untenable.

(3) The Planetesimal Hypothesis, advanced at the beginning of this century by Chamberlain and Salisbury, two great American geologists, and both still living. This theory postulates the origin of the solar system, from a nebula consisting not of gases, but of small solid bodies revolving in slightly different courses round a central core. The nebular threw out great spiral arms and the particles in these, colliding from time to time, gradually formed knots which in the

course of time collected the material of the arms of the spirals round them, and consolidated into the planets, with the central mass of the nebula as the sun. This theory implies that the materials that formed the planets were originally cold and that heat was produced by friction and pressure. The Planetesimal Hypothesis has proved the preceding ones to be wrong, and today scientists consider it contains itself many elements of untruth. As yet, no comprehensive theory has been propounded to replace it, and our ideas as to the early history of the planet are in the melting pot.

Section 4.—The Globe.

Although we have so little accurate knowledge of the early history of the world, and although we know more about the moon, the sun, and stars millions of miles away than we do about what is five miles below the surface of the planet on which we live, still, we do know certain basic facts about the globe which are the foundations for much of the science of geology. These may be summarised as follows:—

(1) The earth is rigid. It does not consist of a "crust" surrounding a molten interior. The speed with which the impulses given by earthquake shocks are transmitted through the earth (they travel over 8000 miles in 21 minutes) in relation to the speed they travel round the surface, is sufficient to indicate that the interior of the globe is of much greater rigidity than the finest steel.

(2) The interior of the earth is at a far higher temperature than would be necessary to melt the materials at the surface. This temperature is induced primarily by pressure, and it is the same pressure which keeps the globe rigid.

(3) While the earth is very rigid, still it is plastic, and will yield to a change of pressure.

(4) The average density of the whole globe is greater than the average density of the rocks at the surface. (S.G. 5.5 as against 2.7). The lighter mat rials form a covering around the heavier ones towards the centre, but are of insufficient quantity to cover the whole surface of the globe. These blocks of lighter material form the continents. On account of this, blocks of the surface of the world occupied by continents do not exert more pressure on the underlying core than blocks occupied by ocean depths. Owing to the difference of specific gravity, the whole crust exerts equal pressure on the core, each block is in, what is called isostatic equilibrium.

(5) If this is upset, the plastic core yields to the pressure, and great geotectonic and continent building movements result.

(6) Volcanoes and similar thermal activities are not connected with the molten interior, but result from a release of pressure resulting in the fusing of portion of the rocks near the surface.

(7) The mass of the world consists of one type of rock material. Existing differences in rock types are due to local and superficial causes.

(8) Change, and not stability, is the order of creation. The surface of the world is continually changing, but is not changing in a haphazard way. It is growing, and, being built according to a plan which can be recognised.

(9) The general relative positions of the great land masses have always been much as we now know them, but they are continually being augmented round their exterior edges.

(10) Whatever was the original condition of the world, it has not grown appreciably colder during the long course of geological history. At the very dawn of history (say, 1000 million years ago), we find ice covering a far greater area of the world's surface than it does today, and the seasons alternating in major and minor cycles much as we know them

Section 5—Continent Building.

As we have indicated, the great landmasses of the world appear to have been relatively permanent since the dawn of geological history. The core of each of the continents consists of the very oldest rock we know, and these cores have not been greatly altered since the earliest times. Round these cores the continents have been built by the addition of successive layers of material crushed against the older and stable rocks from the outside. In this core we find the oldest known rocks of the surface of the earth. They are so affected by compressive movements that their original form is unrecognisable. If later rocks occur on top of the older ones, these have not been affected by great compression. Farther out towards the edge of the continent we find more recent rocks as compressed and contorted as those of the core. If these, in their turn, are covered by still newer beds, we find these have not been so affected, and so on, until in many places on the outer rim of the continents we find the building process continuing, or, for the moment, just completed.

It is recognised that pressure is continually being exerted towards the centre of the earth. Whether this is due to that indefinite and little understood force we call gravity, whether in response to pressure from outside, whether it is due to molecular attraction of the constituents of the earth or whether the process is just one of crystallisation, we do not know. But we are justified in assuming that the materials of higher specific gravity have a tendency to move towards the centre of the earth and to squeeze the lighter materials up into ridges and prominences. The portions of the earths surface occupied by the great ocean depths are evidently those portions with the highest specific gravity, and they have a tendency to move towards the centre of the earth, forcing, in the process, the great land masses, representing the areas of material of lower specific gravity, higher above the relative level.

For some reason, not yet adequately explained, certain centres of the earth's surface

Reached Stability Very Early.

As the portion sof the surface represented by the ocean depths progressed in this gradual movement towards the centre, the edges of these land masses warped in a great incline towards the surface of the sinking masses. These inclines, being one-sided folds and being of very considerable length, are known as geomonochlies. (ge the earth, mono-single, cline-fold.) These produced under the sea bordering the shores of the continents, great submerged plains, known as the continental shelf, on which all the sediments worn from the land were deposited.

As the sinking process went on these blocks of the earth of necessity had to fit into a somewhat smaller space than they had occupied before, and naturally the more dense segments squeezed those of lighter material out. The pressure was greatest between the sinking segment under the ocean depths, and the already stabilised land mass, that is on the geomonoclines where these great deposits of sediments had accumulated.

When the pressure came on these great beds of newly-formed rocks they tended to move horizontally in response, and would have done so had they not been prevented by the mass of already-formed land. As it was, they started to fold and buckle, the portion next to the stable mass bending upwards into fold or geanticline, while the next portion folded downwards into a trough or geosyncline. This folding continued until the compression of these rocks gave the moving pigment all the room it required. If the pressure continued long enough these folding portions were compressed against the land mass until they were compressed to their utmost, when a second and even more series of folds formed out towards the oceans.

The folds thus caused formed a

Fringe of New Land

along the outer edge of that already existing, and against which the pressure had been exerted. Very often the folds were raised into lofty mountain chains bordering the coast of the older land and succeeded out to sea by a great "deep," which in turn was succeeded by the next fold rising in succession, often represented by a chain of islands.

This process is a continuing one. It has been at work from the earliest times, and is still going on; but because it is working on huge masses of solid rock which offer great resistance, the tendency is for it to move in spasms. The pressure increases until it is sufficient to overcome the resistance, and then follows one of the great periods of mountain building which have occurred at intervals throughout the world's history.

The picture we thus get is of a nucleus of solid rock succeeded outwards by a succession of folds decreasing in size and gradually reaching the level of the great ocean deeps. The nucleus has become stabilised, and is solid enough to resist the pressure. The segment of the earth's crust under the ocean deep is exerting the pressure. Between these is a great mass of yielding rock. The upper portion, known as the zone of fracture, is bending, and after breaking under the strain, and in many places is being raised into mountain ranges. The lower portion, known as the zone of flowage, is, as a result of this tremendous pressure, being squeezed into conformity with the folding, and is altering its nature to occupy the less space allowed it.

These processes can be clearly seen in various stages in Australia. Near Broken Hill three separate series of such foldings have been successively folded into older land masses. Later another great mass, with its centre at Cobar, was folded against them. This was followed by another farther east, and finally we have the

Great Dividing Range

on the coast. The Pacific Ocean is one of these areas of greater density, and is continually forcing the rocks of the geosyncline against the continent masses. The Rocky Mountains and the Andies are the most recent examples of this work on its eastern border, and in Japan and the

East Indies and New Zealand the process is going on under our eyes.

The result is that, apparently, our continents are being continually augmented from the outside as the ocean deeps continually sink. Round the borders of the great oceans deposits from the shore are being continually folded into great mountain chains for the processes of erosion to level again, thus building the continents. When once a land mass has reached stability, it is never again subjected to great contortions, and hence all our existing high mountain ranges are of relatively recent age, and the volcanic and earthquake regions of the world are the places where continent building is progressing today.

But much of this is speculative as yet. Our science really starts with the land masses as we find them. The phenomena that mould these continents, however formed to the landscape, we now see are well known, and we will now start to describe them.

A. N. Lewis.

The Gum Tree

Amongst the earliest records that explorers made of their experiences in Australia was the fact that a large part of the land was covered by trees which produced a timber of hard, heavy and durable quality, and which was peculiar for having veins of dark red, resinous gum throughout the wood. For this reason they called the trees by the popular name, which they still bear, of gum trees. Botanists following in the wake of the explorers grouped these plants into genus, to which they gave the name of Eucalyptus. The chief peculiarity noted in this group was that the flowers had evolved an unusual form, in that the colored portion, or corolla, was apparently absent, and its place taken by a cap which fell off at maturity, exposing very numerous stamens.

Research throughout Australia has discovered about two hundred species of gum trees, yet though so numerous, only very few forms have been found beyond the confines of the continent.

The gum tree is the typical tree of Australian forests, and therefore should be recognised as

The Australian Emblem.

It well deserves this position, not only from its many forms, which are almost confined to Australia, but from its universal distribution throughout that area, and above that, for the enormous size which many of them attain. Some eucalypts reach dimensions which vie with the giant trees of California in being the tallest trees of the world, and in favorable situations it is not at all unusual for trees to exceed the extraordinary height of 300ft. The timbers of eucalypts are varied, but always hard and heavy, and the woods produced by this genus are fit to take the place of any hardwood timber of the world, whether oak, ash or mahogany.

In Tasmania we have about twenty different species, and some of these are amongst the noblest specimens of plant life to be found anywhere in the world. The blue gum (Eucalyptus globulus) grows to a very big tree wherever conditions are favorable, and it does so in record time. Fef, if any, trees of other parts of the world produce such a great quantity of wood in a given time as thi stree, and this wood when prope ly mature is of most excellent toughness and durability. Blue gum may be readily known by its long sickle-shaped leaves and large, solitary flowers. An interesting matter concerning this tree is that in its young condition, as well as in response to injury, the leaves are large, have no stalks, and are placed square to the sunlight instead of being pendulous. This is generally considered to indicate that once the tree lived

In a Less Bright Atmosphere.

and as climatic conditions changed to intense isolation, the tree responded by changing from the broad, spreading foliage to the pendulous condition now existing, in order to avoid the evil effects of too intense a light.

The various forms of white gum behave similarly. This tree does not attain the gigantic conditions of the last-mentioned, and may always be recognised by the flowers being small, and with three together in the axils of the leaves.

Stringy-bark, or messmate, is one of our most useful trees. It attains maturity of timber quicker than does bluegum, and is more easily split into thin slabs. It may be recognised, not only by its thick, fibrous bark, but also by the flowers being many together, and the characteristic leaves, which are very unequal in size, on each side of the mid-rib. The thickness of bark has a direct purpose. It protects the tree from destruction by fire. A bush fire must be very intense to kill a stringy-bark.

Gum-topped stringy is our commonest, and perhaps most useful, tree. It is very similar to messmate, only the clothing of fibrous bark is thinner, and does not extend as far along the branches. It is an excellent substitute for European ash.

Mountain ash grows to a gigantic tree, and has similar leaves and flowers to messmate; but the mark is smooth from the base. It readily falls

A Victim to Fire.

The wood is straight-grained and fissile, but is less durable than that of related species. It is commonly called swamp-gum, which is an unfortunate name, as it leads to the belief that it produces inferior timber, whereas for the purpose for which it is best suited it would be difficult to find its superior.

There is a group of gums, consisting of about half a dozen species, which have a very close affinity to cider gum. This latter is very like white gum, with three flowers in each flowering axil; but the leaves are equal-sided, and not sickle-shaped, as in that species. The members of this group vary greatly in the shape of the capsules. Cider gum has small, oblong fruits. Yellow gum, which bears the strongest, most durable and elastic timber of any Tasmanian eucalypt, is very similar to cider, only the capsules are rather larger; heart-leaved gums, with large, globular capsules, and always opposite, stalkless leaves. Urn-gum, with capsule-shaped, like a Grecian urn, and dwarf-gum, with small box-like leaves, which seldom grows more than 3ft. high.

The peppermints are always small trees, but they have two good qualities: they will grow in

Soil Too Poor.

for any other tree, and their timber is most durable. There are three peppermints, black, white, and blue. Black peppermint has narrow leaves, many flowers in the bunch, and fibrous bark. White peppermint is a variation of this, with smaller flowers and narrower leaves, but the bark is smooth from the base. It grows principally on hills. Blue peppermint is very different. The fruit is larger, and the juvenile leaves and also all the leaves on trees growing on poor, dry soil, are opposite, and connate across the stem. The form of blue peppermint which retains the juvenile form of leaves, even when mature, is often called the Risdon gum.

Eucalyptus appear to have one disadvantage, in that they bear very small seeds, and therefore have not a large store of reserve for the young plant to draw upon till it shall be able to construct food for itself. The effect of this disadvantage is greatly increased by the peculiar constitution of the plant demanding for it a full exposure to sunlight. As a rule, owing to the gum trees having pendulous leaves, the light of the sun is but little impeded in its passage through the overhead foliage, with the consequence that below eucalypts the soil maintains a copious vegetation of shrubs and small trees.

The seeds falling from the capsuls reach the soil beneath these shrubs are either do not germinate or, if they do, they are smothered in their infancy. This is why so few young trees are found in a normal gun forest. To combat this eucalypt trees have evolved an effective means of reafforestation. When they have flowered, and set seed in their capsules these

Capsules Do Not Open

and allow the seed to escape, but remains closed during the life of the stalks bearing them. Now if a bush fire comes along it destroys not only all undergrowth, but kills at least all the small branches. This cuts off the moisture supply of the capsules; they dry up, open their valves, and the enclosed seeds fall out on to the now bare soil.

Eucalypt seeds germinate very rapidly, and usually get a fair start from the weeds. There is now a struggle for existence. If the seeds of rapid and dense vegetation happen to be present the young gums will probably have a bad time. On the other hand, if there is any delay, and the eucalypt once get a chance, they being rapid growers, the probability is that there will be a dense crop of young gums, which, in its turn, will for a few years inhibit the growth of underscrub.

The condition of Tasmanian forests is that of most woodlands which have been raised under purely natural conditions. They consist of trees of various ages. Some long past their prime with dead boughs and rotten heart, which are of no service but to supply firewood; a few are in a good state for the axe, and many too young for anything better than poles. This is what you always get where trees have been left to

Fight Out Their Lives

for themselves. There is only one way to secure a better condition, and that is to clear practically everything off the land and raise a new crop all of the same age.

This is hardly reasonable in the present, but with the rapid elimination of soft wood, the day must come when hardwood forests will be of much greater consequence than in the present. Some of our choicest timber; such, for instance, as the yellow gum of Uxbridge, grows in small numbers in out-of-the-way places. It would be a useful thing to plant small experimental areas under pure forest conditions as a test of what can be done with good trees and waste places.

L. Rodway.

Chapter III.

Features of the Landscape

(Dynamic Geology.)

Section 6.—Mountain Building.

Mountains are elevations on the earth's surface which rise above the general level of the country. Height, size and shape are immaterial and of infinite variety. A large extent of high, but relatively level, country is not called a mountain, but a plateau, e.g., the central plateau of Tasmania; in Victoria the term "high plains" is common, and prominences attaining a lesser elevation are called hills. The principles which govern the formation of these three features are similar and the following remarks will, in general, apply to all.

Mountains may be classified into:—

(a) Formation mountains (i.e., portions of the landscape that have been raised to a higher level than the surrounding country by some geographical process).

(1) Folded mountains (i.e., those formed by the folding of portion of the earth's crust in response to lateral pressure).

(2) Block mountains (i.e., blocks of the crust that have been raised bodily above the surrounding country).

(3) Domed mountains (i.e., those formed by pressure from below bulging the surface into a dome).

(4) Volcanic mountains (i.e., those formed by outporings of lava or volcanic ash).

(b) Residual mountains (i.e., those formed from a once extensive elevated tract of country by the removal or sinking of the balance of the landscape).

(1) Mountains of circumerosion (i.e, the elevated areas left when the bulk of the original plateau has been worn away).

(2) Residual block mountains (i.e., the portions of a once elevated plateau that have been left when the bulk of the country has sunk).

The formation of residual mountains is really the story of the formation of the valleys that separate them. We will leave this class therefore until we discuss the development of valleys.

Origin of Mountains.

All the mountains included in the class "formation mountains" owe their origin in some way or another to the same cause. That cause is the same series of earth movements which we have seen is responsible for the addition of belts of new land to the older continent masses, the squeezing of accumulations of sediments, deposited off the coasts of the continents, against the older stable core of the great land masses by the sinking of the blocks of the earth's crust of higher density than the average and which are represented by the floors of the oceans.

A mountain, whether an isolated peak like Mount Wellington or a continental cordillera like the Rocky-Andean chain is essentially a feature of relatively recent growth. Immediately on elevation the weather starts its work of breaking down the newly-formed mountain, and after a space of time, by no means long according to the geological scale, the mountain range is reduced to a succession of rolling hills—"downs," as they are termed in England and north-western Tasmania; plains as they are called in Australia, and prairies as they are called in America.

All the great mountains we now see on the map of the world arose during the more recent epochs of geological time and from the mere existence of a mountain at the present day we can argue the ocurrence of great earth movement at that spot in the no very distant past.

Further, we see from our atlas that all the great ranges of the world are grouped along the outer edges of the important land masses. They are, in fact, the newest layers of land added to the continents, and are the ridges of rock compressed against the older cores of the continents, which the weather has not yet had time to level to a maturer contour. Also we see that the lines of these newly-formed mountain chains are also the lines of volcanic activity at the present time, and also mark the portions of the earth's surface afflicted by earthquakes. These new mountain ranges, volcanoes, and earthquake shocks are all phenomena resulting from the same cause, and are all indications of the building of new land.

Folded Mountains.

When pressure is applied, as above explained, to a bed of newly-deposited and relatively horizontal strata, the first impulse of this bed is to yield laterally. This inclination is resisted by a block of the earth crust more stable than the bed of strata, and if the pressure continues, and is sufficient to overcome the resistance of the strata, folding begins, and the strata are crushed against the stable section, known in this connection as a "remanier block." Folding, therefore, implies pressure, and a stationary mass or anvil against which the pressure is exerted. In any one region pressure comes, as a rule, from one side, and is exerted in one direction, although it is possible for pressure to be exerted from both sides of a block of strata, each locus of pressure acting as the remanier block to the other.

The first tendency is for the edge of the block of strata nearest the remanier block to buckle into a fold. This fold will be at first broad based and flat. As the process continues it will rise into a sharper ridge, and we will see the gradual growth of our mountain range. The fold will seldom be uniform-sided, because the movement, being all from one side, will tend not merely to bend the strata, but to push outside portions under the interior ones.

The pressure will be coming from below and from the outside, not from above, or in an absolutely horizontal plane. This tends to overturn the folds on the older formed rock or on earlier stages the shapes of regular, broad-basgreat beds of the outer portion of the folding strata over, under, or through the inner portions. Thus we get folded mountains assuming in their earlier stagesthe shapes of regular, broad-based, domed ridges, but as the process continues these folds steepen and finally overturns and breaks, leaving ragged edges and broken escarpment, and the grander features of our more lofty mountain ranges.

In Tasmania we have no mountains whose existence in their present form can be ascribed to this process of folding. Certainly the rocks of the western highlands are intensely folded. Probably they formed portion of an ancient mountain chain, but this range has long since disappeared, leaving a mere core of folded and contorted strata. These strata have been raised somewhat, and then blocks have been isolated into the existing mountains at a later date, and by very different processes than the ones that originally folded the rock.

Block Mountains.

The existence of folded rocks is usually an indication that these rocks were at a considerable depth, and hence under great pressure when the pressure was applied, otherwise they would have merely broken. A bed of rock on the surface is in general too friable to bend, but if the pressure was sufficient, would buckle, and break into blocks which would yield to the pressure, and, if necessary, slide over each other. It is only when the pressure is so great that no movement is possible that a solid mass of rocks will fold. Although this is the rule, folding occasionally occurs at the surface in peculiarly favorable conditions, and is now occurring in Papua, New Britain, and British New Guinea.

When the pressure due to depth, and the pressure due to lateral forces are very considerable the rock mass may be reduced to a plastic condition, and assume the qualities of a liquid, flowing in any direction possible. Areas and zones in the crust where this condition exists are known as

"Zones of Flowage."

They can only occur where the pressure is sufficient. In them all pores and fractures are closed, the rocks often take on different forms, and the strata conforms to such shapes as the pressure imposes.

Nearer the surface the rocks are freer to move, and to yield to pressure. The portion of the crust is known as the "Zone of Fracture." Here the beds of strata are not folded, but break. When pressure comes on, this portion, or where the folding of rocks below it, nearer the centre of the earth, exerts forces from below, the strata of this zone of fracture tends to conform to great masses of the landscape, are forced more or less vertically upward, above the general level, and other great blocks tend to sink. Hence we get the formation of the type of mountains we have called "Block Mountains." They are characterised by abrupt faces descending to the neighboring valleys, but their rocks have been pushed up as a whole, and although probably tilted to a greater or less degree in the process, and often much broken, they are not folded or compressed at all.

Block mountains are probably very often the mere conformation of the surface beds of strata to the foldings going on very far below. The portions of the surface, over the upward arch of a fold, being free to move, are forced to a block to a greater or less elevation above the surrounding country and the portions over the downward arch of the strata drop below the general level. But it is

By No Means Certain.

that all block mountains are so formed. The surface of the crust may often adjust itself to differing conditions, or to a general shrinking by breaking into such blocks, some of which are forced up, while others remain stationary or drop, without any corresponding folding below. But, on the whole, it is unlikely that block mountains could be formed on any scale without folding of the strata below.

Block mountains tend to result in plateaus and flat-topped ranges rather than the jagged, fantastic peeks and razor-backed ridges that folding gives us. Most of our Tasmanian mountains in common with the whole of the Great Dividing Range running the length of the eastern coast of Australia, belong to this type.

Mount Wellington, Ben Lomond, the Central Plateau, and all the mountain groups of the south and of the middle west and north-east of Tasmania, show the typical form of block mountains. They have all flat, plateau-like tops, and steep sides, dropping to, usually, broad flat valleys. They are evidently blocks of the surface strata of this portion of the earth's crust that have been forced up to their present elevation as blocks. There is often a certain amount of tilting, but no folding.

It is unknown, as yet, whether these block mountains represent merely an attempt of the surface strata to adjust itself to a smaller space necessary through the general shortening of the earth crust, or whether the pressure from the eastward or south-eastward—that is from the Pacific basin, more particularly the Tasman Sea basin—has

Squeezed These Blocks

up to form the mountains we now see. The writer suggests the latter alternative is the more probable.

Perhaps our more important mountain ranges are merely the surface indications of great folding movements that have occurred deep down in the earth. It seems quite possible that pressure originating as has been described was applied from the south-east and east on the great deposits of sediments washed from the ancient land that once existed to the west, of which our West Coast mountains are a fragment, and deposited off the coast of this land. The ancient rocks of the West Coast supplied the remanier block against which these sediments were squeezed. Deep down in the crust, folding resulted, which has not yet been exposed, it having occurred in relatively recent times. The largest fold occurred nearest the old and stable rock masses. Farther east this was followed by a great trough with a lesser fold, and a lesser trough farther east, and finally the smallest fold of the three in the vicinity of our present East Coast. These folds, as is usually the case, were by no means regular, but more pronounced in some places than others, and were broken by many transverse folds at approximately right angles to the main lines.

The surface strata not being restrained by any pressure or weight of superimposed rock, did not fold, but broke into great blocks in conformity, giving us elevated tracts or block mountains over the upward folds, and

Dropping to Deep Valleys

over the downward folds. Thus, where the largest fold occurs nearest the ancient rocks of the western side of Tasmania we have the most elevated blocks of these newer mountains—La Perouse, the Hartz Mountains, the Snowy Mountains, and Mount Wellington, Mt. Field Ranges, Mt. Gell and its neighboring ranges, Mt. Olympus, the Du Cane Ranges, the Pelions to Barn Bluff, and Cradle Mountain.

This mass is followed by a line of great valleys—D'Entrecastreaux Channel, the Lower Huon, the Derwent and the Forth Valleys. Farther east, there is a lower and less defined series of mountains, Bruny Island, the mountains east of the Derwent and the Central Plateau being the most striking.

These in turn are followed by another line of valleys—Petta Water, the Coal River Valley, the Midlands Valley, drained by the Macquarie River, the lower South Esk Valley and the Tamar. Finally, along the East coast there is a line of mountains, also decidedly of the block type, but of less altitude than the others, and from which the East coast drops sharply. In the north-east corner of Tasmania, there are also some older rocks, and against these pressure has also been applied, giving us the

Ben Lomond-Mt. Victoria Plateau,

separated from the East Coast tiers by the valley of the Upper South Esk.

This theory to explain the origin of our mountains is advanced here for the first time. It is still only a theory, and has yet to be proved, but all earlier theories attempting to explain the reason for our mountains are more or less erroneous and this one avoids some of the worst objections that can be raised to the others. It is here only given in barest outline; in fact, only as an indication of a possibility and must not at present be stated as if it were an established fact.

We must now pass on to our next type.

Domed Mountains.

Great beds of strata are seldom of the same material throughout, but more usually hard and soft layers alternate. When pressure is applied during folding movements, naturally, layers of different hardness respond differently. The layers of hard rock tend to fold, pucker, and sometimes to break and overthrust other layers. If the stress is so tremendous that the relief given by these movements cannot accommodate the rocks to their restricted space, the individual particles and minerals tend to re-arrange themselves, and alter so as to occupy less space. On the other hand, soft rocks cannot stand the strain which would merely bend hard layers, and are crushed beyond recognition without much opportunity to fold, and are squeezed between the moving layers of hard rock and forced into cavities where they occur.

It is well known that although ordinary water turns into steam at 100 deg. C, water in ordinary engine boilers attains a temperature double that degree before turning to steam, and special appliances can be made whereby the temperature of water can be raised to 1000 degrees or more without it turning to steam. This is

Because of the Pressure

it is under, and the greater the pressure the greater the temperature the water can attain without turning to steam. Bu immediately the pressure is released wate over the temperature of 100 degrees wil forthwith become steam.

Similar principles hold good with roc masses. During folding processes a hea is generated by the pressure far in ex cess of what would be required to mel these rocks at the surface, but the sam pressure prevents their fusing. But ofte spaces, pockets or fissures, will occur Often a hard layer will arch as the resul of the pressure and leave a cavity below It is the softer rocks which are feelin the stress of the pressure most and ofte when this pressure is released, by, per haps, the arching of a layer above, o the slipping of some higher bed acros another, or by the rising of a block of th crust as the result of the pressure, som of this soft rock will fuse; that is, be come molten.

This, in its turn, tends to relieve th strain, due to the folding. Instead o having to squeeze solid rock, there is onl the resistance of a liquid to be overcome The pressure exerted against this force it through cracks and weak points in th surrounding rock. Its own heat tends t melt more and more of the surroundin strata, and thus a "magma pocket" i formed. These, as can be seen, usuall occur under the upward arches of th folds. As the pressure continues, quan tities of this molten magma are force through the surrounding rocks, in larg sheets (sills), or upward pipes (dykes), o irregular-shaped masses (laccoliths). Th force of the pressure is much more effec tive on this molten matter than on th resistant sold rock, and where it ca

Merely Fold and Twist

the latter it can force the molten materia right out of the affected area.

Often this molten magma is formed nea the surface through the release of pres sure caused by the displacing of a surfac block of strata, or again it may be force towards the surface by the great pressur below. When it reaches a spot where it own pressure is sufficient to bend th strata above it, it forms a "domed moun tain." This type of mountain alway has a core of rock that has been onc molten, called igneous rock, which, of it own power, has forced the overlying roc up into the mountain we now see, an this overlying rock is bent round th igneous rock. Such mountains are terme laccoliths when the igneous material i in the form of a definitely bounde magma pocket, and a batholith when th igneous material has no ascertainabl bottom.

Naturally, rock may fuse and form pockets, or sills, of igneous material with out having sufficient power to bend the superimposed strata. It then does not form a domed mountain, but is found merely as a mass of igneous rock embedded in rock of different structure.

Most of our mountains of central, east and south Tasmania are of these natures. Few definite laccoliths or domed mountains have yet been identified. The Domain, Hobart, is probably a laccolith, and similarly many smaller hills of the East Coast. Trinity Hill, Hobart, certainly appears to have been formed by the strata being bent by igneous rock from below. But most of our mountains in this part of Tasmania are masses of igneous rock thus formed, but which have not had any definite effect on the overlying strata. They stand in their present posiion not through doming the surrounding rock, but either through raising it bodily s the result of being squeezed upward y the same process as originally fused he original rock, or by being lifted bodily y later, though similar, forces, after aving entered and transgressed the arlier sediments.

Volcanic Mountains.

As is natural, when the molten magma being squeezed and pressed through verlying rocks, some will often reach he surface. We then have a volcano. hese are important, but quite subsiiary, agents of mountain building. The olten material usually works along a eak bed of strata or up a crack or weak lace in the fold. Usually these are und on the forward side of the folds; at is, the side opposite from that from hich the pressure is being exerted. It the continuance of the pressure due the folding process that forces the olten material out on to the surface, d causes volcanic eruption.

If the molten rock pours out on the rface, we have lava flows. These are ten of great extent. In the Deccan, in dia, one ancient lava flow covers 200,000 uare miles to a depth of over a mile. third of Victoria is covered with ancient lava flow, and similarly most the North-West and North coasts of smania. If the lava is viscid on reachg the surface, it often piles up into lls of considerable height. Many hills und Melbourne are so formed, but in smania there have been no volcanoes very recent date, and with our heavier infall the

Ancient Lava Flows

ve been greatly reduced, so there are w hills which we can definitely say were due solely to a lava flow. The hills of Droughty Point, south of Bellerive, are due to this cause, and the hilly country round Deloraine, between Devonport and the Forth, from Burnie to Waratah, and round Stanley and the extreme North-West, are all relics of old lava flows, much cut into, however, by the numerous streams which cross them.

Often very little lava pours from the vent of the volcano, but from the crater showers of stones, ashes and mud are thrown into the air. These in time build up very considerable mountains, known as volcanic cones. Mt. Egemont, Mt. Ruapelin, and Mt. Tangariro in New Zealand are so formed, and are sufficiently high to be permanently snow-capped. In Tasmania, we evidently had at one time many of such mountains, but they have not survived our rigorous climate. Cornelian Bay cemetery, the recreation ground at Lindisfarne, Fort Alexandra Hill at Sandy Bay, were once volcanic cones, and there were dozens up the Derwent Valley and through the Midlands and along the North coast; but such mountains composed of fine ash and mud are very soon levelled by the action of the weather.

Thus the ancient idea of a volcano as being a pipe connecting the mountain with the molten core of the earth, or as being a natural safety valve is quite erroneous, and we have endeavored to explain that all mountains are built by the processes generated by the sinking of the heavier blocks of the earth's surface, squeezing lighter portions out and upwards. Some writers use the terms "epeirogenic," or continent making, movements to describe the formation of block mountains and "orogenic," or mountain making, movements to describe the formation of folded mountains; but these terms are misleading. As we have endeavored to explain, all types of mountains are but different aspects of one great process; all are but different results of the one cause. Finally these processes are infinitely slow. No mountain is formed by them alone. As soon as a mountain begins to raise its head above the surrounding country running water and the weather begin to attack it, and these forces really give the figure to the surface, and determine the details of its outline; the mountain building forces merely giving its general substance.

Section 7.

Folds

Having seen how these features have their origin we must now discuss them in somewhat greater detail and determine their peculiarities so that we may recognise them when we meet them in the field.

They may be of any size, from a bend a few feet high such as can be easily studied in a road cutting, to one many thouasnd feet in radius and covering several miles, in which case it isoften only possible to detect its existence by measuring the dip of the rock in many places and tracing one layer of rock over a large area. The arch or upward bend of the fold is known as an "anticline," and the trough or downward bend as a "syncline." Where one occurs the other is usually to be found on one or both sides. Greatly folded rock is a succession of anticlines and synclines. When the strata is only slightly folded into long indulations the folds are spoken of "open folds." With further compression "close folds" may be formed, and if the compression has been so intense that the different ayers are bent into a series of parallel vertical bands the folding is isolimial if each side of the folding is at the same inclination the folds are termed "symmetrical." Often one side

Is Pushed Over

owing to the pressure coming from one direction. The fold is then known as an "overturned fold," and if the process has been continued to its utmost limit it is called a "recumbent fold."

In regions that have been subjected to much folding, the larger folds often have smaller ones superimposed on them, and these in turn may have still smaller ones down to tiny "foliations." With folding there is a tendency for the particles to become separated and even individual minerals to develop stress cracks known as "rock cleavage." Often cracks develop and these become filled with minerals of a different nature forced into them under pressure, or deposited from circulating water.

All these types of folding can be seen and examined in any short section of our West Coast. In a cutting just south of the Zeehan station is a splendid example of a symmetrical close folded anticline, barely four feet high, and with a base of similar measurement, a perfectly regular curve. Along the north coast from Ulverstone to past Table Cape can be se[en] a splendid series of folds outcropping [on] the beach. As you go along in the tra[ck] you can notice that the jagged edge [of] the strata appears to be dipping at a ve[ry] steep angle. Further along these rock[s] gradually assume a steeper and steep[er] angle until they are standing vertical and finally turn over, and are to be se[en] dipping in the opposite direction. Th[is] is repeated many times along this sectio[n] of the coast. It is an indication that [we] are looking at a

Series of Huge Folds,

the tops of which have been worn of[f]. Many of these folds are several mile[s] across. Just west of the Coo-ee sal[e] yards, a mile or so west of Burnie, they can be seen to perfection. Here ar[e] many small synclines and anticlines. Th[e] top of one anticline is so perfect that i[t] resembles the top of a circular concret[e] drain running out to sea. We here se[e] excellent examples of both open and clos[e] folds.

East of Maria Island ancient rock ha[s] been twisted to such an extent that onc[e] horizontal bands of strata are now to be seen with a sharp bend at the bottom from which the band runs vertically for over 500 feet to a sharp bend at the top, and so on in a series of parallel pleats, the same band being bent until it occurs only a few yards from the continuation of itself in the neighboring folds. These are wonderful instances of isoclinial folding—a very rare type.

Many of the mountains of the West Coast appear to have their outline governed by overturned folds. The gentle slope up one side followed by a sheer face on the other is often, although not necessarily, an indication of an overturned fold. Although none of this type of folding has been recorded it is almost certain that the twisted rocks of the west can provide many examples

In addition to a simple folding, secondary folds are often superimposed on the original ones; in fact, this is the general rule. In the rocks near Cooee, mentioned above, there are three series noticeable. First, there has been a major folding resulting in a series of great folds.

Many Miles Across,

and probably several thousand feet deep. These themselves consist of a succession of small folds ten to twenty feet across. Again another folding has taken place in a direction normal to the others; that is, while the first have the succession of anticlines and synclines in a vertical succession the series shows waves in the strata in a horizontal direction, that is, along the surface of the ground.

At Cradle Mountain an even more intense folding is evident. Large folds are apparent in all the cliff faces; that at the head of Crater Lake, for example. But in addition to these, the rock has been folded in every possible direction and in many degrees until the smallest gives it the appearance of a succession of ripple marks. These can be the result of one intense compression and may have been caused at relatively the same time; but often it is evident that they have been the result of successive earth movements. Thus, in the Mt. Lyell district the rock was first folded into a saucer-like shape; then later the edges of this were pleated by a series of minor folds. Most of the mineral bearing regions of the West Coast have been subjected to at least two series of folding movements separated by a very great length of time.

Another type of fold, called by Mr. E. C. Andrews the drag fold, occurs at Broken Hill. Here there were two layers of very hard rock about four miles apart, and separated by beds of soft rock. During compression these hard layers moved horizontally and one

Dragged or Rolled

the soft rock against the other hard layer. No instance of this has yet been reported from Tasmania.

This intense folding in probably every case occurred in the zone of flowage. These beds of rock have been let down so deep into the earth that the particles under inconceivable pressure and heat thereby generated have become plastic, and when the folding movements have occurred the rocks have yielded as if they were putty. A mile or so west of the Leven at Ulverstone there is a bed of what was originally a conglomerate of round stones, the size of cricket balls, set in a fine matrix. This has been folded, but so great was the pressure and so pliant had the particles become that these embedded stones have stretched or been compressed in exact conformity with the rest of the rock until now, what were at one time round waterworn pebbles, have been stretched out for, in some cases, eighteen inches, and have been bent round following the lines of the fold without breaking. The pressure necessary to do this cannot be imagined.

Folding of all possible types can be seen wherever the older rocks occur in Tasmania. Anywhere west of a line from Cradle Mountain southwards, in many places along the shore of the North Coast from Cape Grim to the Tamar, around Beaconsfield, south of Sheffield, west of Fitzgerald, and in many places round Gladstone and from Fingal to Bicheno, every variety of folding may be seen.

Section 8.

Faults and Earthquakes

As we have seen, while the strata in the zone of flowage normally folds in response to pressure, that in the zone of fracture normaly breaks. The formation of block mountains implies a series of such breaks on a large scale. But besides these, the surface of the earth is always having to adjust itself in a smaller or a greater degree to varying conditions below, and there is a continual movement between blocks of the surface rock; some rising, others sinking.

Now, if we have an extensive bed of strata under half of which the crust is gradually sinking or rising, while the other half is stationary, a stage is reached when something must give way. If the movement is very slow and the rock soft, or under considerable pressure, it will tend to drag and gradually to bend at the junction between the moving and the stable portion until a more or less uniform curved slope connects the two. This resembles one side of an ordinary fold, and is called a "monoclinal fold.' But a monoclinal fold approximates rather to a fault than to a fold. The best example of such a feature is to be found in the Blue Mountains east of Sydney, where the level sandstones bend from the top of the mountains to the plains 2000-3000 feet below without breaking.

If, instead of a gradual movement the sinking or elevation is rapid the tendency will be for the bed of rock to

Break at the Junction.

This will allow the moving portion to respond to the influences from below freely, and the result will be that in one place strata will be found at a different level from strata elsewhere that was obviously laid down at the same time; but, besides this difference of level, showing no signs of compression or other earth movements. This break is called a "fault."

A simple break is termed a normal fault, and its existence is indicated by this fact that any given layer of rock when followed along to the fault suddenly stops there, the other side of the fault being rock of a different layer, or even of quite a different series. A break caused as described above is seldom a simple fracture. More usually there is an area of broken rock with many small faults. Sometimes the rock is so broken that its structure has been destroyed, and in extreme cases it may be reduced to rubble. This is known as "fault breccia."

In very hard rock the fault may be a fine, straight crack, and the sides may be polished by the force of the slipping rock. This polishing is known as "slickenside." Sometimes it can be seen that there has been continual movement up and down along a fault line. Sometimes the edges of the strata adjacent to a fault are dragged round towards the other block.

These are the features exhibited when a bed of rock is broken by portion sinking or rising in relation to the rest. Sometimes faults may be occasioned by lateral pressure in the same way as folding. In this case, when the pressure has come on the

Side of a Bed of Rock

instead of folding it has broken. Often it will bend in the middle and then break. This form is common amongst our sandstones throughout Southern Tasmania. At other times when the rock breaks one portion is forced over the other. This is termed an "overthrust fault." Often the edges are dragged round into a monoclinal fold. Faults may have a displacement or as it is called a "throw," of any number of feet, from great tectonic faults, showing a movement of several thousand feet down to ones of hardly perceptible throw. Many of these smaller faults are mere local adjustments, penetrating only a few layers of rock and may be called "creep faults."

As we have shown, the western portion of Tasmania gives us every possible example of folding. The eastern portion on the contrary shows little folding, but is broken in every direction by faults of all descriptions and sizes. It is prob ly impossible to follow a bed of rock southern, central, northern or eastern T mania for a mile in any direction wi out meeting a fault of some descriptio

We have first the major block faul The country is broken into segments, all different altitudes from sea level 5000 feet. The edges of these vari blocks are all huge faults—whatever t cause. For example, rock of the sa original bed occurs. At sea level at H bart, and on the slopes of Mt. Welli ton, not four miles away, it is to be se at an

Elevation of 3300 Feet.

Similarly the faces of the Western Tie Ben Lomond, the East Coast mountai Mt. Field, the mountains south of th Huon and all the lesser hills in south eastern Tasmania, show displacements the beds of rock to an equal extent.

Then these beds, each at its own heigh have been broken by many faults of less size. Probably the Derwent is worki down one of these, as evidenced by th cliffs at the rocks near New Norfolk, Bedlam Walls, near Risdon, and at th Bluff, at Bellerive. The Tamar is als probably following a fault line, up th side of which the main line climbs be tween Launceston and Evandale Jun tion.

Our whole coast is probably determined by three large faults, but certainly man of the details are fixed by small one Bass Strait is probably a block of land dropped below the general level by series of faults running along the Ta manian and Victorian coasts. The coastal faults have not been a clean brea but a series of minor criss-cross faults, in tersecting each other and running at a angle to the general line of break.

In addition to all these, our rocks are broken by innumerable smaller faults. Especially is this true of our coal fields —coal measures being particularly fragil rock and notoriously broken. These small faults have been the greatest hindrance to coal mining in Tasmania, and at least one good colliery—Sandfly—was forced to close solely on account of

The Innumerable Faults.

When a seam is being mined and a fault is met with the coal-bearing layer on the other side of the fault is lost and much unprofitable work is necessary to pick it up again. If this occurs too often a stage is reached when the quantity of coal won will not pay for the work of cutting out barren rock to get at it.

In Tasmania the common sandstone originally rested 500 feet above the common blue and brown limestone. Very frequently these rocks may now be seen alongside each other. This occurs on the Huon-road, in Lenah Valley, in Glenorchy Valley, and on the New Norfolk-road east of Sorell Creek. This always indicates the existence of a fault. All our mining fields are bounded, limited and traversed by faults, and every one of the bulletins of the geological survey describe many. Faults are by no means confined to the block mountain regions of the east. The folded rocks of the west have their share.

EARTHQUAKES.

These catastrophies are merely the apparent results of movements in the earth's crust. When a fault occurs, or when, during folding, beds of strata break, the adjacent surface suffers an earthquake. The causes are the causes that produce folding and faulting, and have been sufficiently discussed. Earthquakes are common today wherever mountain building is going on; for example, all round the outer edge of the land bordering the Pacific. They also occur through minor adjustments of stresses after the building processes are complete.

If the strata are very resistant the strain will be resisted until it becomes too great, when the rock will give way with considerable displacement and

A Great Earthquake

like the recent one at Tokio will result. If the rock is not resistant it will give gradually, a little at a time, as strain comes on it and minor earth tremors only will be the result. In Tasmania mountain building movements are fortunately completed for the time being, and we are not subjected to earthquakes on a large scale; but Bass Straits is decidedly an earthquake zone, and small tremors are recorded from there nearly every year. These are probably caused by slight slippings along a fault line, a few inches at a time, and due to adjustments of stresses after a period in the recent past of considerable earth movements. No place on the earth's surface can be said to be definitely immune from the possibility of earthquakes.

Section 9.

Volcanos, Geysers and Hot Springs

It has already been explained that these activities are merely incidental phenomena of mountain building processes, due to the forcing of molten material close to the surface. A volcano is merely a vent from a magma reservoir to the surface and a geyser, or hot spring, is merely a vent from a supply of water accompanying molten rock or reaching it from the surface. Many volcanos have commenced activity within historic times, and under scientific observation. The first sign is usually a fissure traversing comparatively level country, from which molten rock has appeared to flow (really it has been squeezed). This molten rock, or lava, consolidating round the vent soon builds up a considerable mountain through which the subsequent eruptions burst.

These fissures can all be traced to the lines of great earth movements, and correspond with folding or block faulting of the underlying segments of the crust. In the most intensely active volcanic regions of the world the volcanic cones and vents are all arranged in lines corresponding to these fissures, with the largest volcanos where two fissures cross.

Fissure Eruptions.

The grandest of all volcanic eruptions have been those in which the entire length and breadth of the fissure have been the passage way for the upwelling lava. These have provided the great lava flows of antiquity which we can still trace today. Their origin is due to the qualities of molten material accumulated below the surface, and the pressure generated by earth stresses sufficiently powerful to eject such a mass of material. Along the whole of our north coast are huge flows, many of over 100 square miles in area, of unbroken lava. In Victoria well over 20,000 square miles is covered in this way. These great flows are the result of a series of fissure eruptions, and are signs of earth movements of a major degree. Throughout Tasmania many smaller areas are covered with ancient lava flows, and yet there are very few places in which it can be definitely said that a volcano existed. Basalt—a rock that was once lava—stretches from Pontville to Bridgewater, and is found at the back of Kingston, and around Sorell and Richmond, and in many other places without the slightest trace of the previous existence of a volcano. These occurrences are probably the result of fissure eruptions on a small scale.

Lava Flows.

These may be distinguished petrologically by the nature of the rock as will be explained in a later chapter. They can also be distinguished in the field by typical characteristics. When a mass of crystaline rock can be seen filling up a valley, and overlying older rocks, it is safe to assume that it must have flowed there as lava. Very often by tracing such a rock the course of ancient river valleys down which the lava flowed can be discovered. As this rock is invariably very hard it sometimes happens that, if the original valley sides were composed of soft rock, these have later been weathered away, and the lava flow which originally occupied the lowest portion of the valley is left as a ridge.

Usually the mechanical effect of flowing molten material has left its mark on the subsequent solid rock; that is, you can see at a glance by its existing arrangement that it once flowed to its present position. Often it picks up blocks of other rock as it travels, and these can now be found embedded in a rock now much harder, and often pieces of lava which have solidified sooner than the mass, have been broken off, and can be found also embedded in the later cooled masses of the same rock. Air bubbles are frequent in lavas, and show in the solidfied rock as holes or vesicles. These may at times show the direction of flow, and sometimes they may tend to become elongated in the direction the lava originally moved.

As the flow cools cracks are formed, generally normal to the cooling surface. These indicate the position of the original surface long after this has been removed. As the top or bottom of the flow is usually the cooling surface these cracks tend to develop vertically, and to divide the rock into columns. These columns are often very perfect, and are a very common feature of solidified lava flows. They are to be seen par excellence at the Burnie breakwater, and in the quarry behind it, where also the fall of the lava over the former sea bank can be traced in the now solid rock. Columns are also well developed in the Jordan Valley, just north of Bridgewater, at New Norfolk, just west of the Derwent Bridge, and in many other places. If the lava fell into water a characteristic form is seen known as "pillow lava," the columns being divided by horizontal joints, making a form resembling a pile of square pillars, piled one on top of the other.

Volcanic Cones.

Seldom does a volcano emit lava alone from its crater. Much water accompanies the magma as an original constituent, and much more is collected from surface soakage. What pressure is released by the molten lava reaching the surface, this water converts into steam, and when the pressure generated by this steam is greater than the containing pressure of the liquid lava, an explosion results. During an eruption these explosions are more or less constantly occurring in proportion to the quantities of water present, and the viscocity of the lava. This has two results, firstly, molten rock, instead of flowing out of the crater as lava is hurled in blocks high into the air, and secondly, the lava itself is broken by smaller explosions to an ash or a froth, which in turn is ejected by larger explosions, and spread round the country side. Most of these blocks of disintegrated lava, and the ashes so ejected fall close to the crater mouth, and thus in time build up a mountain, or volcanic cone, at the top of which is to be found the crater. Most lava flows are inter-stratified with layers of ash and scoria (the "lava-froth"). These are very common in Tasmania around the remnants of ancient volcanos, and can be found in many places along both sides of the Derwent and through the Midlands and along the North Coast. Cornelian Bay Cemetery and the recreation ground at Lindisfarne—to give but two examples—consist of beds of volcanic ash and scoria. A cloud often descends the slope of the volcano during an eruption. This was once thought to be steam, but during the eruption of Mount Pelee such a cloud exterminated a whole town. Such phenomena were then more carefully studied, and were found to be microscopic fragments of white-hot lava shattered by explosion, and instantly fatal to any form of life.

Plugs and Necks.

These volcanic cones are usually composed of loose ash and boulders of broken lava, and unless protected by subsequent lava flows do not long withstand the attack of the weather. Thus, although all the typical volcanos of today have this form there are few definite cones preserved from the much greater eruptions of antiquity. But often lava wells up through the crater and eventually consolidates there. When the soft ash of the cone is washed away this solid core remains, often as a hill of considerable height. At Mt. Pelee such a plug was pushed many thousands of feet into the air by the great eruption.

Lava Mountains.

Although lava usually flows like a molten river, down the nearest valley or spreads in a sheet over a plain, sometimes owing to the viscosity through being nearly solid when erupted or through containing minerals that solidify very quickly (these and their effect will be iscussed later under Petrology), the lava oes not flow or spread, but piles up into idges and hills near the crater. Many f our so-called basaltic hills, as those at Droughty Point, Bream Creek and round ork. Plains appear to have been due to his. Sometimes solid lava covers, and o protects, a volcanic cone, at other imes it may partly cover a bed of loose sh, the portions so covered being protected and standing out as ridges and ills when the unprotected portions are emoved.

Minerals from Volcanos.

Volcanoes seldom possess the requisites ecessary for the formation of minerals o commercial proportions, but sometimes large quantities of sulphur are rapped in a crater or ash bed. Sulphur is btained from these sources in New Zealand. Various forms of lime are occaionally so deposited and are very useul when found. The great diamond mines f South Africa are all located in deep olcanic pipes, and the intense heat appears to have been largely responsible or the formation of the gems.

Hot Springs.

When water in quantities accompanies volcanic eruption, it may reach the surace in a heated condition, and the existnce of volcanic activity below the surace may raise the temperature of ordiary underground water so that the noral spring water is hot.

The especial significance of these theral activities is due to the fact that eated water, often under pressure and ar above boiling point, is able to dissolve minerals from the rocks through which it travels much more readily than old water, and that when it drops in emperature, on reaching the surface deposits these minerals. We thus get ery pure beds of the various minerals so eposited, and the wonderful effects haracteristic of a hot spring are so ormed. The pink and white terraces of Lake Rotomahana, in New Zealand, were splendid examples of what a hot spring can build by depositing different layers of minerals in this way.

At Geilston Bay, in places behind Sandy Bay, and in Upper Burnett street, West Hobart, there are traces of existence of ancient hot springs in the vicinity of Hobart. In these places there are deposits of a very pure limestone (travertin), which shows unmistakable signs of deposition from a hot spring. In the deposit at Geilston Bay leaves of trees growing near have been preserved in the lime water flowing from the spring.

Hot springs are usually the last phase of volcanic activity, and are found when the actual craters have become extinct, but the deeper regions of the earth are still sufficiently hot to warm up water percolating down to them. In periods of full volcanic activity the water mingles with the lava and causes steam pockets, explosions and ash rather than coming to the surface merely as a hot spring. The so-called hot spring near the Kimberley railway station, between Deloraine and Latrobe, has not had its waters heated (75 deg. F. is its usual temperature) by thermal action, but by the chemical action of decomposing limestone below.

Geysers.

These spectacular phenomena are merely perversions of the normal type of hot spring. When, through a restriction in the channel, or from another cause, the column of water forming a hot spring can become heated at unequal temperatures throughout its length there is a possibility of lower parts of this column of water being converted into steam which then ejects the water column above it This column of water is known as a geyser. Hot springs may become geysers, and active geysers in time usually remove the obstruction which causes their existence as such and become hot springs again.

A. N. Lewis.

"Some Tasmanian Reptiles"

Snakes are undoubtedly the representatives of this division of our fauna to which most attention is paid by the casual observer, yet, strange to say, very little regard is given to their classification, and Tasmania is credited often with numerous species which it does not possess.

There are but two classes of snakes in Tasmania, the ordinary venomous land snakes, and the rare (as far as our island is concerned) sea snakes. The number of species is very limited, as the land snakes have but three representatives, whilst but two species of sea snakes occasionally wander as far South as the Tasmanian coast.

There are no harmless snakes in Tasmania, nor have we any tree snakes, pythons or death adders. The three terrestial Tasmanian snakes

Are All Poisonous.

but these constitute the sole danger in the bush. The various species of lizards which are referred to so often as "death adders," "blood suckers," or other such designations, are, in reality, quite harmless. The most evenly distributed, as well as the most dangerous Tasmanian reptile, is the tiger snake (Notechis scutatus). Care must always be taken when dealing with the tiger snake, especially in the early summer, which is the breeding season. This species, as with others, shows very considerable variation as regards coloration, and the various vernacular designations which have been given to the color varieties has tended to confuse matters. For instance, bush dwellers usually refer to the dark colored snakes as black snakes, and the lighter forms as carpet snakes. Both terms are incorrect, as neither the true black snake, which has paired caudals, nor the true carpet snake, occur in Tasmania. The typical tiger snake has the body scales in 15 to 18 rows, ventral plates 150 or more, and the sub caudals which are entire, 40 to 60. The central scale on the head

Is Shield Shaped.

almost as broad as long. This feature alone immediately distinguishes it from the other species. In the typically marked specimens the body color is golden brown, crossed by almost 50 bands of dark brown. The average length is 5 feet, and there is one specimen in the Tasmanian Museum which measures no less than 6 feet 2½ inches.

The only other Tasmanian snake which at all approaches the tiger snake in size is the superb snake (Denisonia superba). This species is also known as the copper headed snake, the large scaled snake, and the diamond snake. The last designation is totally incorrect, as the true diamond snake is a python and a variety of the carpet snake which does not occur in Tasmania. In the superb snake the central shield in the head is approximately twice as long as broad. The color varies from black to reddish brown, whilst the average length is from three to five feet.

As regards the color of the Tasmanian snakes in general, it is particularly necessary to remember that this shows great variation. For instance although

A Typical Tiger Snake

is golden brown on the body, crossed by bands of dark brown, yet they are occasionally met with almost black, or even in sandy country almost white, and the superb snake, although lacking the banded coloration, has similar changes as regards the general color.

The third land snake is the small white-lipped whip snake, which can be immediately identified owing to the white markings on its lips, and the central scale of the head, which is thee timres as long as broad. The whip snake is plentifully distributed over Tasmania, and is found not only near the sea shore, but also particularly plentiful on the mountain summits.

The two sea snakes which occasionally reach Tasmanian waters are the wandering sea snake, a species which grows to about 3ft. in length, having a body coloring of olive and a number of encircling black rings; and the

Spotted-tailed Sea Sanke,

in which the scales are laid edge to edge and which is black above and yellow below, the tail being yellow, spotted with black.

A Stray Turtle.

There is another representative which is grouped in the reptilian class, although of quite distinct order, namely, the leathery turtle, which is occasionally met with in Tasmanian waters; but it is only on very rare occasions that it is found so far south, and as the whole turtle group is but a relic of a bygone fauna, such visitors tend to be less and less in the progress of the years.

Lizards and the Harmless Dragon.

Returning to the land fauna, there are some interesting examples amongst the numerous lizards which occur in the island. For instance, the several mountain dragons which are commonly met with under rocks, etc., especially on the hillsides. These interesting little animals, which are repulsive-looking in some ways,

Are Quite Harmless,

although generally credited with being dangerous "blood-suckers," and numbers are often killed by those who do not understand the true place of these lizards in the scheme of Nature. There are also the several rock lizards occasionally referred to as "death adders," and credited with being possessed of many poisonous qualities, which they do not have.

Two species of the large blue-tongued lizard are met with in Tasmania, and they are often referred to as "goannas" or "iguanas," but such designations are misleading, as iguanas are much larger reptiles, of a different character, and which occur on the mainland.

In addition to the foregoing there are a large number of species of the small lizards, which occur in such numbers, not only in the bush, but in suburban gardens. Most of these lack vernacular designations, although they have naturally been duly classified with regard to their scientific titles.

Clive Lord.

Section 10.

The Attack of the Weather

In the previous sections we have seen how masses of the earth's crust may be raised above the general level, and so form land and how these masses may be added to. But immediately a section of land appears above the level of the ocean and even before it is attacked by various processes which modify the effect of the building influences, impose the details of topography on the landscape and generally tend to level the surface of the country. Indeed, they are at work long before the building processes are complete. The more pronounced the building movements and the greater the elevation given to the landscape by them the greater the powr of the levelling agents; so wherever these agents have been at work for long the bolder fatures imparted by the building movements have to be levelled to rolling plains. This general levelling of the surface of the landscape is spoken of as erosion.

Agents of Erosion.

The agents by which erosion may wear away the rocks of the surface of the earth may be grouped under three main heads:—

(a) The weather.
(b) Water.
(c) Life.

The effect of the various agents in these groups to some extent overlap. For example, it is difficult to fix a point where rain ceases to have the erosive effects peculiar to the weather, and to attain these grouped under the heading "running water." Again, the weather may so effect running water as to turn it into a flow of ice which presents very different characteristics. Also life depends directly on climate, and the absence or otherwise of the erosive forms due to life may be considered a sub-division of the heading "weather."

The Weather.

Under this heading we group the effect that (1) The atmosphere; (2) changes of temperature; (3) frost; and (4) wind have on the landscape.

The weather effects all portions of the earth's surface. While a river may present more visible evidence of the work it is doing in wearing down the countryside, its work is confined largely to its channel; but the weather is at work always. Night and day it is slowly, but certainly, disrupting the rocks of the earth's crust. Naturally this effect is more powerful on the summits of high mountains, or on exposed rock faces, but it penetrates everywhere, and no depth of soil or covering of vegetation is a complete protection. Also the weather very materially assists the other agencies.

Air.

The air has very little erosive effect of itself. If the atmosphere contained throughout the year relatively the same degree of moisture, varied little in temperature, and was comparatively still, it would scarcely affect the rocks at all.

But no region with a climate absolutely so constituted exists. It is only as the bearer of moisture and the vehicle of change of temperature and varying air currents or winds that the air is of importance in this regard. The chemical effect on the rocks is considerable, but this is only possible through the agency of water, and will be discussed in the next section.

Changes of Temperature.

In most parts of the world the change of the average temperature during the year is considerable, and there is also an even greater change in between the day and the night temperature. In fact only those portions of the globe which are permanently under ice escape the effects of this change. When the temperature is high, the particles constituting the rocks or soil expand, and when it drops they contract. This, although slight, is regular and the mechanical effect is very powerful. It tends to loosen the grains in the cementing material which binds them together, or to disrupt the particles themselves. It subjects the rocks to a series of tiny strains which, as the process continues, develops into cracks which present a weakness for water, frost and wind to act on.

This process is the most active agent of erosion in the desert portion of Australia, where the temperature often rises from nearly freezing to over 100deg. F. in an hour after sunrise. And it must be remembered that it is the direct rays of the sun that beat on the rocks, and that the action is again increased by the fact that rocks diffuse heat more quickly than the atmosphere does. In Tasmania the action of this agency is obscured by the action of frost, with us a much more powerful erosive; but on a hot summer's day the bare rocks of our mountain tops become unpleasantly hot, and the temperature there falls to the vicinity of freezing point within a few hours of sunset.

FROST.

When the change of temperature extends to its maximum range the lower limit descends below freezing point. Then, as well as the mechanical effect of the expanding and contracting rock particles, another agent of erosion comes into play. Water percolating through the rock is frozen as the temperature drops below freezing point, and is thus made to expand. This tears the rock grains apart, and widens and loosens joints and cracks. The power of ice is very considerable, and no rock can resist it. Its effect is, of course, felt very slowly, but it is very sure. When the ice thaws again, the joints and cracks are left open for more water to accumulate, and the ice, after each succeeding freeze, has greater power, until it finally tears the particles apart.

Frost makes its effect felt all over Tasmania during some parts of the year. Its maximum work is done in places where water freezes every night, and thaws again next day. This occurs for about nine months of the year on our higher mountain tops. It also occurred around the edge of the ancient glaciers, and its effect there will be discussed at greater length later.

On most of our mountains capped with diabase, water has entered the joints which traverse the rock vertically, and the regular effect of frost has been to tear this solid rock in blocks from the parent mass, and split it off in great columns. Near the edge of the top of the mountain these appear as "organ pipes," and on the tops of the ridges as accumulations of boulders usually referred to as "Ploughed Fields." Anyone familiar with our mountain tops knows this type of country only too well, and its peculiar features are due almost entirely to the action of frost on a rock with regular, vertical points, in which the water can accumulate.

The summit of Mt. La Perouse is covered with sandstone, which frost has flaked into broad, flat slabs no thicker than a school slate, and which now lie over the whole surface of the mountain. Many quartzite mountains of the West have had the rock of their tops broken into tiny sharp chips like the chipped marble often spread over graves. Several mountain tops around Cradle Mountain are covered with this. Frost is the responsible agent.

Frost is active to a lesser extent in the lower country, but is always at work during the winter months on every exposed rock surface.

WIND.

Wind drives particles of rock separated from the mass against other portions of still solid rock. These have a powerful erosive effect. This is very noticeable in desert country, where the wind-blown sand carves typical forms from protruding beds of rock. These are identifiable, as they could not have originated in any other way. They often assume fantastic figures. In Tasmania we have many examples of this weathering. Its greatest effects are to be seen on cliff faces. Most of the small caves above high-water mark round the coasts and the numerous caves in the sandstone and mudstone cliffs in-common in the sandstone cliffs on the land are due to wind. These caves are slopes of Mount Wellington, on the mountains on the east of the Derwent, and throughout the Midlands. On the floor of caves formed by wind is usually found a deposit of fine particles worn from the rock from which the cave has been weathered, and the way the wind attacks the soft layers in a cliff face is most noticeable.

The effect of wind seen thus to its greatest advantage on cliff faces is also present wherever a bare face of rock is exposed to alternating or even to regular breezes.

A. N. Lewis.

Some Tasmanian Parrots

Parrots are always interesting, even to those who take very little interest in bird life. Their usually bright coloration makes them conspicuous, and as they make good case birds they are often kept as pets. Their paired feet and stout bills are characteristic of the whole parrot order. Specimens of one species or another are to be met with in most parts of Tasmania, although with the advance of settlement certain of the more terrestrial species are becoming rare.

Amidst the tall timber of the mountains the piercing notes of the black or white cockatoo often may be heard, whilst amidst the smaller timber the green parrot is common. Amidst the more open timbered plains the brightly-colored rosellas are common, whilst the brush-tongued parrots or lorikeets often are to be seen in flocks in the flowering eucalypts.

Three species of lorikeets, or brush-tongued parrots are met with in Tasmania, the most conspicuous of these being the rainbow lorikeet, which has its head, throat, and abdomen blue, chest red, whilst the upper plumage is green. This species is to be met with usually in flocks, particularly among

The Tall, Flowering Eucalypts.

The birds are very fast fliers, and cover large areas of country in search of food.

The commonest lorikeet in Tasmania is the musk lorikeet. The general color of this species is green, whilst the forehead is red and there is a distinctive red streak behind the eye, which, together with the pronounced yellowish patch on each side of the lower breast, serve as distinctive features. This lorikeet is noted, not only for its loud screeching amidst the eucalypt blossom, but also for its excursions into the orchard and gardens of the cities. The smallest brush-tongued lorikeet found in Tasmania is the little lorikeet, which in bow. It is the smallest of the purely size is only about half that of the rain-Australian family loridae. The red coloration of the forehead and sides of the face, the absence of the red streak behind the eye, and the general small size of the bird, form easy points for identification.

As a contrast to the foregoing small example, the black cockatoo may be mentioned, as it is the largest of the Psittaciformes, and is well distributed over the island. The identification is easy, owing to its large size, general black plumage, with the yellow ear coverts and the distinctive yellow band on the tail.fl This species is particularly

Fond of White Grubs,

which are to be found in decaying wood, or under the bark of their trees. With the aid of its very powerful bill the black cockatoo can tear open the dead bark, or make a veritable burrow into decaying beech (the so-called "myrtle") logs.

The gang gang cockatoo has a plumage of slate grey, whilst the male has a prominent red crest. It is seldom noticed in Tasmania, but it is common on King Island. The white cockatoo of pure white plumage, but with a distinctive yellow crest, is found in many parts of the country. This cockatoo is very intelligent, and when a flock descends in a farmer's grain paddock a sentinel is usually posted to warn if danger approaches. This sentinel is relieved at regular intervals.

The galah, or rose-breasted cockatoo, was not noticed in Tasmania until recent years, but as several small flocks have escaped from captivity they will probably increase in numbers.

There is but one record of the occurrence of the cockatoo parrot (a small brown form with a prominent crest), and this bird was probably an escapee.

One of the

Best Known Specimens

in Tasmania is the green parrot, or green rosella, which is also known as the mountain parrot. The general color of this species is green, the forehead red, cheeks blue, with the under parts yellowish. This species is confined to Tasmania, where it is fairly common, particularly amidst the smaller eucalypts which fringe the larger forests. It is also met with high up on the mountain, for which reason it has obtained one of its common vernacular names.

Another well-known species is the white-cheeked rosella, the distinctive plumage of which serves to immediately identify the bird which is to be met with througout Tasmania wherever conditions are suitable. On King Island there is an additional form, the Crimson rosella.

Two very interesting green parrots or parakeets occur in the island, the blue-winged, which is widely distributed, and the orange-breasted both of which occur here. The former species can be recognised by the blue band on forehead, blue wing, and the entire greenish yellow color of the under surface; whilst the orange-breasted species has under surface of an orange yellow with distinctive orange markings, the upper plumage is green, whilst there are blue markings on the wing and forehead. The frontal band of this species is usually much paler than in the blue-winged form, and serves as an eas distinguishing mark apart from other con siderations. As with all forms which fre quent the ground these species are feel ing the extension of settlement and are much rarer than formerly.

One form of the parrot tribe, concern ing which there has been much discus sion with regard to its exact classifica tion in the family group, is the Swift par rot. This species is often found in com pany with the lorikeets, which it resemble greatly in some general respects. Swif parrots can be distinguished by the

Swiftness of Their Flight,

the red forehead and throat and the blu on the crown of the head. In certain years this species is to be found in great numbers in some districts, but they are a semi-migratory form and appear to travel large distances.

The final representative of the parrot order in Tasmania is the interesting ground parrot which is a purely terrestial species now becoming rare on account of its numerous enemies, more particularly introduced cats which take such a heavy toll of our bird life in general. The ground parrot can be easily recognised by its distinctive plumage which is green barred black and gold. This interesting form has always been of interest to naturalists. It was first described in 1792. The French expedition which visited Tasmania in 1793 fully described this interesting form, and published illustrations of it.

Clive Lord.

"Some Notes on Whales"

The ordinary naturalist has not many opportunities to study these gigantic cetaceans. Possibly, during the course of his sea voyages, he may have seen them at a distance. A few skeletons have been noticed in museums, and if by chance one has been observed stranded on the shore, especially if it has been there some time, the average person is only too anxious to get as far away as possible. Whales are, therefore, rather difficult to study. They cannot, as a class, be handled and examined such as butterflies, or even birds.

Nevertheless, whales are of great interest, and many facts have yet to be gleaned concerning not only their habits, but more especially the part which they play in the evolutionary trend of animal life in general. One question which is of interest to naturalists has been the elucidating of the problem concerning the animals from which whales evolved. It must be remembered that a whale is a true mammal, and not a fish as it is sometimes termed. Many consider that whales originated from one of

The Most Primitive Families

of the Carnivora, but their aquatic habits throughout untold generations have entirely changed these animals so much in character that a vast amount of painstaking research has been necessary in order to gain the knowledge which is possessed by the world today, and a very great deal yet needs to be done in this as in other branches of science.

Whales have become essentially adapted ror an aquatic existence. The tail has become the main means of locomotion, whilst the hind limbs have practically disappeared, although vestiges are found in certain species, whilst the fore-limbs have been reduced to mere paddles.

Life in the water and the resultant constant pressure on the head, together yith the fact that the head is held practically motionless while swimming, has had a modifying effect upon the skull and the neck bones of the whale. As with all mammals with one or two minor exceptions the neck bones, or cervicle vertebrae, are seven in number, and they become compressed to such an extent that they are proportionately shorter than in any other animal, and in some species the majority are fused together.

To describe the changes which have taken place in the Cetacean skull would entail the use of more time and more technical language than is possible in the present instance; but, nevertheless, the subject of the various changes is a study of great interest.

To turn to more general matters the fact may be recalled that whales generally

Are Remarkably Uniform.

in shape, although they vary in size; in fact, the first essential of a whale is like the snake, to be large whenever the matter is discussed without undue attention to scientific accuracy. The giant of the ocean—the Blue Whale—may reach 100 feet in length.

As regards the classification of whales they naturally fall into two sub-orders—the whale-bone whales (Mystacoceti) and the toothed whales (Odonticeti) the latter including the dolphin family.

The whalebone whales (Mystacoceti) are naturally the more valuable group commercially. Owing to the cosmopolitan nature of the Cetacean order as a whole it is a matter of difficulty to say with any degree of certainty exactly which species occur in Tasmanian waters.

The origin of whalebone obtained from whales is often misunderstood. This is not "bone" in the true sense of the word, but is evolved from the hard palate. Owing to this wonderful structure the teeth have atrophied, and in certain whales have become rudimentary, and only appear in early life. As these early teeth degenerate they are replaced by long triangular plates of whalebone, set at an angle, and frayed on the inner side of the jaw. This arrangement allows the whale to progress through the water and sieve out the small animalculae, commonly called the whale food of "Brit," upon which these huge creatures feed. The animal elevates the tongue, and thus drains off the liquid through the plates of whalebone, the fringes cut out of the inner edges retaining the essential portions of the whale's diet, after which the mouth is closed, and the food swallowed.

The toothed whale (Odontoceti) are by far the larger group, and the division contains forms ranging from the

Huge Sperm Whale

to the small dolphins. An interesting fact is that the skull of the toothed whales is always more or less asymetrical.

The beaked whales (Ziphidae) form an interesting group of the toothed whales. Such forms as Hyperodon Mesoplodon and Ziphius occur in Tasmanian waters, but they are seldom obtained, and there is not a great deal known about them.

The family Delphinidae, includes the fierce "killers" and the smaller dolphins. The latter are usually called "porpoises" by Tasmanian fishermen, but they are, strictly speaking, dolphins. The dolphins can be distinguished by the deep grooves on the palatal surface of the maxillaries, and by the larger number of teeth.

Clive Lord.

Section 11.

Erosion by Running Water

In the last section we showed how the weather is continually at work breaking down the rocks of the surface of the world. A far more important agent in the process of levelling the landscape is running water. The action of the weather merges into that of runnig water, for which rain falls in any quantity the surface soil cannot absorb it all, and some runs a greater or less distance over the surface, and even portion of the water that soaks into the soil or rocks emerges at a lower level to run in streams over the surface. While the weather is at all times engaged in wearing away exposed surfaces, water only affects certain restricted channels; but the result is far stronger and possesses much greater power than the slow effect of the weather. So much so that frequently the result of a single shower is apparent. The effect of the weather may be

Compared to Decay.

whilst that of running water resembles wear, and is often referred to as "abrasion." The weather affects the whole surface similarly if with differing intensity; but running water affects the landscape in an almost infinite varieties of ways, and so must be dealt with at greater length, although here only the broad principles can be referred to. It is difficult to give particular examples here because they exist everywhere. In a day's walk along any river, creek, or natural rainwater channel, all the features here described may be seen.

Mechanism of Stream Erosion.

As soon as water commences to flow over the surface of the earth, either after a fall of rain or from a spring, it starts to wear away portion of the surface. Its work is seen as the excavation of its channel. In the earlier stages such runnels form only after a shower. The weight of the water removes particles of loose soil and carries them with it down the slope, until its power is checked by the exhaustion of the supply or by the disappearance of slope sufficient to enable it to obtain momentum. The many trickles towards the top of a slope will one by one unite, and thus gain greater volume and hence power until finally a permanent stream grows from innumerable small runnels. The stream carries out its own function in the erosion process, as will be explained, but it is only the result of many streamlets, and is only working in the lower portion of a larger valley. The tiny tributaries erode the sides and the head of the main valley, and do the real work of removing the bulk of the landscape. The amount they can perform depends on (1) the volume of water; (2) the slope; and (3) the hardness of the rocks.

The Volume of Water.

It is obvious that if the first motive power possessed by the streamlet is its own weight, then as the weight of water running over the surface increases so will its erosive effect increase, and the streamlet with the most water will wear out the larger channel. But mere volume of water, except in the first instance, has very little effect of itself. It must be realised that pure water has little power to wear away rock; its power is given by the particles it carries with it, in much the same way that the paper portion of a piece of sandpaper has little use in smoothing a piece of wood, but merely carries the grains of emery which tear away the fibres of the wood. In both cases the paper and the water only carry the sand grains which do the real work.

But, taking the simple case of a rainwater channel formed in soil after a shower, the greater the volume of water the greater the weight of soil which it can move down the slope. This gives the stream its first start, and until the soil and broken surface rock are removed volume alone is all that is required to wear out a channel. And it is this tiny streamlet formed after a passing shower that is the most active and persistent of all the factors that are engaged in levelling the landscape. The work of one is slight, but there are so many, and they are so readily formed, and are at work so universally that they are continually washing the loose material separated by the action of the weather from the surface of the hills down to the valleys from which places the streams remove it.

In this early stage the volume of water usually depends on the amount of rain falling in a given time. The heavier the shower, the less of it the soil can absorb, and the more it has to run down the hill side. Also the more frequent the showers the more frequently will water run in the courses of the streamlets.

The Slope.

Water, of course, can only move when there is a certain slope, and it requires no mental effort to realise that the steeper the slope the greater the speed with which the water will run, and hence its greater erosive and transporting power. If the rate of flow of a stream is doubled, the weight of material it can carry increases to 64 times. So while rain falling on level ground either sinks into the soil or lies as stationary pools, and has little mechanical effect on the landscape, rain which falls on a hillside in any quantities scours channels in the soil, which vary in size with the slope of the hill. In their earliest stages these rain water streams merely carry off as much soil as the volume of water, and by the velocity imported by slope gives them capacity. But if the process is at all regular, the surface soil is soon removed from their channels, and they commence to wear away the solid rock below.

Hardness of the Rocks.

Now the third factor comes into play. Naturally the softer the rock the easier this work will be. In the case of a sandstone, for example, the streamlet will in a short time erode a considerable channel, but if the rock is a compact, igneous mass it will have very little effect. Where a piece of country contains small areas of rocks, varying in hardness, the streams will wear deep, and broad channels in the softer ones, and gradually divert the fallen rain from the areas of harder rock, which will in time be left as ridges and spurs. Thus we see so many of the hills and spurs of our hilly country capped with the hard rock diabase—these portions being more elevated simply by the removal of softer beds of rock surrounding them.

Rain Water Channels.

When the area drained by any given watercourse is large enough, a stream will be formed that is perennial, and not dependent merely on a passing shower; but it is the small rain water runnels that largely build up the stream. The stream with its greater regularity and power develops special characteristics, but it must be borne in mind that it is only at work in its own channel at the bottom of a valley. In the course of time these valleys work further and further into the tableland, whence they rise, and are continually widening their own valleys. This headward and lateral erosion is the most powerful agent at work levelling the landscape, and this work is accomplished, as has been explained, by the rain water channels worn by the water from each shower that cannot be absorbed where it falls.

These channels, therefore, must be put first as the most active agents of erosion. Much of the erosive mechanism of streams and rivers, to be described next, can be traced in these small watercourses, and all the features presented by a great river may often be seen within a few yards along the course of one of these rain channels.

Vegetation Control of Erosion.

We have explained that the most powerful agent at work reducing the landscape to a level rounded topography was the number of tiny runnels and stormwater streamlets formed after rain at the heads and sides of the main streams. It is appropriate here to notice a very important modification given to the natural action of these streamlets by the hand of man. Left to themselves, these storm water gutters very soon erode away the side of the hill, until a slope is attained over which water can just flow.

As explained before, if the slope is greater than this, the power of the streams is increased enormously, and hence they very soon reduce the slope to a gentle grade.

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(To be Continued.)